SECTION 3
EXISTING CONDITIONS

Southern Florida today is characterized by highly productive agricultural regions and rapidly growing urban areas. These areas directly abut extensive aquatic and wetland ecosystems that are in serious states of decline, largely as a result of water management activities required to support the agricultural and urban systems. A burgeoning urban population occupies most of the higher elevation areas of the Lower East Coast. Extensive agricultural areas cover much of the interior of the peninsula north and south of Lake Okeechobee and along the western fringes of the Lower East Coast. Both urban and agricultural land uses require increasing levels of water supply and flood control.

A channelized and degraded Kissimmee River is currently undergoing ecological restoration. A diked and highly regulated Lake Okeechobee has been reduced in area by half with the loss of extensive littoral wetlands. It now requires frequent regulatory water releases to maintain lowered water levels defined by water regulation schedules. The regulatory releases severely damage the St. Lucie and Caloosahatchee estuarine ecosystems.

The Everglades have also been reduced in area by half due to agricultural and urban expansion. The remaining Everglades ecosystem is in a continuing state of decline largely as a result of altered water regimes and degraded water quality, as evidenced by vegetation change, declining wildlife populations and organic soil loss. In contrast, the Big Cypress region, although modified from its natural condition through major man-caused disturbances (eg. logging, oil and gas exploration, residential development, recreation uses and agriculture). is in relatively good condition as an ecosystem. At the downstream end of the system, Florida Bay, the Gulf of Mexico, and Biscayne Bay estuarine ecosystems experience altered salinity regimes due to decreased freshwater heads and inflows from the Everglades, with damaging effects on habitats, nursery grounds, and estuarine fauna.

The situation in south Florida today, as summarized here, can be attributed largely to a diminished capacity to retain the huge volume of water that once pooled and sheet flowed across the pre-drainage landscape. These waters are now either discharged in massive volumes through canal systems to tide or are stored at unnaturally high levels in remnant diked wetlands of the Everglades. In hindsight, many of these problems are now recognized to be unanticipated effects of the existing Central and Southern Florida (C&SF) Project. They are exacerbated by the inescapable reality that people continue to move to south Florida at one of the highest rates in the nation. The result is a currently non-sustainable system of

urban, agricultural and natural environments in south Florida that exceeds the capacity of, or is hampered by, the existing system of water management.

The following discussion is a brief summary of the existing physical, ecological, and socio-economic conditions within the study area. It does not attempt to provide comprehensive coverage of all resources or concerns; rather its purpose is to provide a summary account of the baseline resources present in the study area and which may be affected by implementation of the Comprehensive Plan. Further information on existing conditions within the regional system, and the ten study regions is available in ***Appendix J***. Detailed information on existing water quality is available in ***Appendix H***, existing air quality in ***Appendix I***, and socio-economics in ***Appendix E***.

3.1 GEOLOGY AND SOILS

The geology and soils of south Florida represent many of the opportunities, constraints and impacts of regional water management. The high transmissivity of the Biscayne Aquifer allows rapid recharge of Lower East Coast well fields while it sets the stage for water competition between the Everglades and Biscayne Bay regarding the issue of seepage control. The loss of peat soils of the Everglades provides an indicator of ecosystem change due to drainage activities. The geology and soils of south Florida are important aspects of the hydrologic and ecological framework for the Restudy. Peat soils predominate in previously flooded areas. Peat soils have subsided as a result of oxidation due to drainage, which has affected local topography and hydroperiods. "With peat breakdown, there has been a release of stored phosphorus (previously contained in the peat) into the system.

The Kissimmee River Basin is poorly drained due to the low permeability of fine to medium grained Pamlico sands that were deposited as marine and estuarine terraces during the Pleistocene to Holocene age. Lake Okeechobee and much of the Everglades are underlain by peat and muck that developed in a shallow basin with poor natural drainage under prolonged conditions of flooding on top of the Fort Thompson Formation of Pleistocene interbedded sand, shell and limestone. Bedrock in the Everglades is almost entirely limestone.

The Big Cypress Basin developed on top of sandy, marly, fossiliferous limestone and sand of the Tamiami Formation of Pliocene age. Fine sand and loamy soils with poor natural drainage and scattered areas of rock outcrop overlie the limestone of the Big Cypress Basin. The sandy and loamy soils of the upper East Coast and the Caloosahatchee River Basin lie on top of the Anastasia Formation of variably shelly and sandy limestone and provide moderate natural drainage.

The Lower East Coast on the Atlantic Coastal Ridge is mostly underlain by thin sand and Miami Limestone that are highly permeable and moderately to well drained. To the west of the coastal ridge, soils of the Lower East Coast contain fine sand and loamy material and have poor natural drainage. Rockland areas on the coastal ridge in Miami-Dade County are characterized by weathered limestone surfaces and karst features such as solution holes and sinkholes. Higher elevation marshes of the southern Everglades on either side of Shark River Slough are characterized by calcitic marl soils deposited by calcareous algal mats and exposed limerock surfaces with karst features such as solution pits and sinkholes.

Florida Bay is underlain by burrowed bryozoan facies of Miami Limestone with a highly variable sediment cover consisting of sand, exposed bedrock and mudbanks. Ten Thousand Islands consists of sand that creates barrier islands underlain primarily by the Tamiami Formation. Because of the low relief, numerous marshy backbays or lagoons, such as Whitewater Bay, occupy exposed limestone surfaces behind the slightly higher sand buildup of Cape Sable. The Florida Keys are made up of the highly permeable Key Largo Limestone in the upper Keys and the less permeable Miami Oolite on the lower Keys.

South Florida contains three major carbonate aquifer systems. The surficial aquifer system comprises rocks and sediments from the land surface to the top of an intermediate confining unit. The discontinuous and locally productive water bearing units of the surficial aquifer include the Biscayne Aquifer, the undifferentiated surficial aquifer, the coastal aquifer of Palm Beach and Martin Counties and the shallow aquifer of southwest Florida. Practically all municipal and irrigation water is obtained from the surficial aquifer system. The intermediate aquifer system consists of beds of sand, sandy limestone, limestone and dolostone that dip and thicken to the south and southwest. In much of south Florida, the intermediate aquifer represents a confining unit that separates the surficial aquifer system from the Floridan aquifer system. The Floridan aquifer system is divided by a middle confining unit into the Upper and Lower Floridan aquifers. North of Lake Okeechobee, the Floridan aquifer system yields fresh water, although it is more mineralized along coastal areas and to the south. In the Upper East Coast, the Upper Floridan aquifer is used for drinking water supply. In the Lower East Coast, from Jupiter to south Miami, the Upper Floridan aquifer is being considered for storage of potable water in an aquifer storage and recovery program. In the Lower Floridan aquifer there are zones of cavernous limestones and dolostones with high transmissivities. However, because these zones contain saline water, they are not used for drinking water supply and are used primarily for injection of treated effluent wastewater.

3.2 CLIMATE

The subtropical climate of south Florida, with distinct wet and dry seasons, high rates of evapotranspiration, and climatic extremes of floods, droughts and hurricanes, represents a major physical driving force that sustains the Everglades while creating water supply and flood control issues in the agricultural and urban segments. South Florida's climate, in combination with low topographic relief, delayed the development of south Florida until the Twentieth Century, provided the main motivation for the creation of the C&SF Project 50 years ago, and continues to drive the water management planning of the Restudy today.

Seasonal rainfall patterns in south Florida resemble the wet and dry season patterns of the humid tropics more than the winter and summer patterns of temperate latitudes. Of the 53 inches of rain that south Florida receives annually on the average, 75 percent falls during the wet season months of May through October. During the wet season, thunderstorms that result from easterly tradewinds and land-sea convection patterns occur almost daily. Wet season rainfall follows a bimodal pattern with peaks during May-June and September-October. Tropical storms and hurricanes also provide major contributions to wet season rainfall with a high level of interannual variability and low level of predictability. During the dry season, rainfall is governed by large-scale winter weather fronts that pass through the region approximately weekly. High evapotranspiration rates in south Florida roughly equal annual precipitation. Recorded annual rainfall in south Florida has varied from 37 to 106 inches, and interannual extremes in rainfall result in frequent years of flood and drought. Multi-year high and low rainfall periods often alternate on a time scale approximately on the order of decades.

3.3 AIR QUALITY

The existing air quality within south Florida is considered good, and the region attains all National Ambient Air Quality Standards. An air quality concern that is not addressed by National Ambient Air Quality Standards is the atmospheric deposition of mercury. Detailed information on existing air quality is available in ***Appendix I.***

3.4 NOISE

Within the major natural areas of south Florida, external sources of noise are limited and of low occurrence. Rural areas have typical noise levels in the range of 34-70 decibels, and urban areas may attain 90 decibels or greater. Noise is not considered to be an issue in the development of the Comprehensive Plan.

3.5 VEGETATION

The location of south Florida between temperate and subtropical latitudes, its proximity to the West Indies, the expansive wetland system of the greater Everglades, and the low levels of nutrient inputs under which the Everglades evolved, all combine to create a unique flora and vegetation mosaic. Today nearly all aspects of south Florida's native vegetation have been altered or eliminated by the development, altered hydrology, nutrient inputs, and spread of exotics that have resulted directly or indirectly from a century of water management.

Riparian plant communities of the Kissimmee River and its floodplain are recovering from channelization and drainage. The macrophyte communities of the diminished littoral zone of Lake Okeechobee are now contained within the Hoover Dike. They remain essential for the ecological health of the Lake but are stressed by extreme high and low lake levels and by the spread of exotics. Below the Lake, all of the pond apple swamp forest and most of the sawgrass plain of the northern Everglades have been converted to the Everglades Agricultural Area. Also eliminated is the band of cypress forest along the eastern fringe of the Everglades that was largely converted to agriculture after the eastern levee of the Water Conservation Areas cut off this community from the remaining Everglades. The mosaic of macrophyte and tree island communities of the remaining Everglades within the Water Conservation Areas and Everglades National Park is altered even in seemingly remote areas by changes in hydrology, exotic plant invasion, and/or nutrient inputs.

The problems of the Everglades extend to the mangrove estuary and coastal basins of Florida Bay, where the forest mosaics and submerged aquatic vegetation show the effects of diminished freshwater heads and flows upstream. These problems are exacerbated by sea level rise. The upland pine and hardwood hammock communities of the Atlantic coastal ridge, interspersed with wet prairies and cypress domes and dissected by "finger glades" water courses that flowed from the Everglades to the coast, remain only in small and isolated patches that have been protected from urban development. In contrast, much of the vegetation mosaic in Big Cypress Swamp to the west of the Everglades remains relatively intact. The importance of south Florida's vegetation, in regard to its unique and diverse composition as well as to its critical linkage to the region's fauna, makes its current state of degradation a major concern and objective in any ecological restoration initiative.

More detailed documentation of existing vegetation focuses on wetland systems that have been most seriously degraded and that receive most benefits from the Restudy. Those systems include the Everglades peatland, the Everglades marl prairie and rocky glades, and the mangrove estuaries and coastal basins of Florida Bay and southern Biscayne Bay. Other natural systems in south Florida

that already have restoration plans, that have lesser impacts from man, or that are not addressed by the Restudy are described in the Appendix. These systems include the Kissimmee River, where restoration is already in progress, Lake Okeechobee, for which a revised regulation schedule has been developed to protect littoral macrophyte communities, Big Cypress National Preserve, where vegetation impacts and fixes are relatively minor compared to the Everglades, and the Atlantic coastal ridge, where pinelands and hardwood hammocks are little affected by the Restudy.

The Everglades peatland that remains in the Water Conservation Areas and in Shark River Slough of Everglades National Park consists of a mosaic of sawgrass (*Cladium jamaicense*) plains, wet prairies, sloughs and tree islands that are oriented in the directions of flow patterns in the pre-drainage system. Sawgrass commonly forms monospecific strands throughout Everglades peatlands. Cattail (*Typha* spp.) has replaced sawgrass in phosphorus enriched areas, and the exotic melaleuca *(Melaleuca quinquenervia*) has invaded sawgrass in peripheral and overdrained areas.

A less dense wet prairie community characterized by spikerush (*Eleocharis* spp.), maidencane (*Panicum hemitomon*) and other emergent macrophytes grows at slightly lower elevations than sawgrass. The wet prairie blends into a more open water floating and aquatic community characterized by white water lily (*Nymphaea odorata*) and bladderwort (*Utricularia* spp.) in the lowest elevation water courses between the sawgrass ridges.

Wet prairies and sloughs support a luxuriant growth of attached algal communities known as periphyton, which form an important base of aquatic food webs and which are also diagnostic of water quality and hydrologic conditions in the Everglades. Wet prairies and sloughs also provide habitat for aquatic fauna and for feeding wading birds. Sawgrass is filling in wet prairies and sloughs in much of the remaining Everglades peatlands, probably as a result of lowered water levels. Sawgrass has been observed to revert to wet prairie after peat-burning fires. Cattail is filling wet prairies and sloughs in phosphorus enriched areas.

Tree islands dot the landscape in the form of either teardrop-shaped larger islands or round smaller islands. The heads of larger teardrop-shaped islands support swamp forest trees such as red bay (*Persea borbonia*), wax myrtle (*Myrica cerifera*) and dahoon holly (*Ilex cassine*) in the Water Conservation Areas and tropical hardwood trees such as gumbo limbo (*Bursera simaruba*), pigeon plum (*Coccoloba diversifolia*) and West Indian mahogany (*Swietenia mahogani*) in Everglades National Park and southern WCA-3A and WCA-3B. The tails of the islands often support willow (*Salix caroliniana*) and other more water-tolerant species. The smaller round islands are referred to as battery islands or bay heads and support willows or swamp forest species. The larger islands originated approximately 1,200 years ago, while the smaller ones are about 700 years old.

Tree islands provide valuable habitat for their unique forest plant assemblages and also for the vertebrate species that depend upon them, particularly during high water. Tree islands have been destroyed or damaged by lowered water levels, which have resulted in tree island and underlying soil burnout, as well as by unnaturally high water levels that have killed the less water tolerant tree species.

The higher elevation wetlands that flank either side of Shark River Slough in Everglades National Park support the highly diverse landscape of the marl prairie and rocky glades. This mosaic of short stature sawgrass, wet prairie, muhly prairie, and tropical hammock tree islands grows on marl and exposed limestone substrate in areas where the marsh naturally would dry for two to four months during most years. The wet prairie community of the marl prairie and rocky glades shares some species with the wet prairies described above for Everglades peatlands, but it grows under drier conditions and includes the most species rich wetland plant assemblage in the Everglades.

The wetland communities of the marl prairie and rocky glades support a distinct calcareous periphyton mat from which the marl substrate is formed. The periphyton mat is an important base for aquatic food webs and protects aquatic fauna from desiccation during dry periods. The muhly prairie community is particularly important as critical habitat for the endangered Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*). Tree islands in this landscape support a diverse assemblage of tropical hardwood species mixed with temperate species. Shortened annual duration of flooding in the marl prairie and rocky glades landscape presently supports a primarily terrestrial community that is flooded briefly each year rather than a primarily aquatic community that dries briefly each year. Impacts to vegetation include the loss of species richness in wet prairie communities, the conversion of muhly prairie to sawgrass, the invasion of woody and exotic trees and shrubs into prairie communities, and tree island burnout.

The mangrove estuary between the freshwater Everglades and Florida Bay and southern Biscayne Bay supports a mosaic of mangrove forests, tidal creeks, salt marshes, coastal lakes, tropical hardwood hammocks, and coastal basins. Red mangrove (*Rhizophora mangle*) swamp dominates the landscape along with stands of buttonwood (*Conocarpus erectus*), black mangrove (*Avicennia germinans*) and white mangrove (*Laguncularia racemosa*). Tidal creeks dissect the mangrove forests and are often bordered by salt marsh communities of black sedge (*Schoenus nigricans*) and cord grass (*Spartina* spp.). Tropical hardwood hammocks with canopy trees such as West Indian mahogany, Jamaica dogwood (*Piscidia piscipula*), strangler fig (*Ficus aurea*) and holly grow on elevated coastal embankments.

Coastal lakes and basins support seasonally variable beds of submerged aquatic macrophytes that range from low-salinity to marine communities of bladderwort, widgeon grass (*Ruppia maritima*), Cuban shoal grass (*Diplanthera*

wrightii) and turtle grass (*Thalassia testudinum*). Reduction in freshwater heads and flows from the Everglades, in concert with sea level rise, has caused community shifts in the submerged aquatic vegetation of the coastal lakes and basins and apparently has contributed to the filling in of tidal creeks. A salinity regime favoring an increased frequency of high salinity events and a decreased frequency of low salinity events in the coastal lakes and basins has resulted in the loss of the low-to-moderate salinity macrophyte communities that seasonal populations of migratory waterfowl once utilized. Tidal creeks, with open water, visibly high flow velocities, and freshwater flora and fauna that were observed earlier this century, have filled with red mangroves to the point they are no longer recognizable today.

3.6 FISH AND WILDLIFE

The life cycles, community structures and population densities of the fauna of south Florida are intricately linked to regional hydrology. The current status of fish and wildlife has been strongly influenced by the cumulative effects of drainage activities early this century, the Central and Southern Florida Project, and the ensuing agricultural and urban development that was made possible by those activities. A major emphasis of the Restudy is to remedy many of the hydrologic aspects of the flood control project that in hindsight have been deleterious to fish and wildlife. Likewise the major emphasis in this section is on those faunal groups that appear to have declined as a result of hydrologic changes caused by the Central and Southern Florida Project and that are expected to benefit from the Restudy. The major linkages between hydrologic alterations and fauna that are addressed by the Restudy and emphasized here include the collapse of aquatic food webs and populations of higher level consumers that depend upon them, shifts in habitats to those less favorable to faunal communities, and the reduction in the spatial extent of the undeveloped greater Everglades wetland system. This section integrates our best current understanding of those linkages, with the recognition that our understanding will continue to improve but will always be incomplete. Thus the information presented here represents many converging lines of evidence that together have produced a sound hypothetical framework of how the south Florida wetland and estuarine systems presently function under the current management system. A more comprehensive catalog of all faunal groups in the region is found in ***Appendix J.***

A critical link in the aquatic food webs, and one that appears to have been broken by hydrologic alterations, is the intermediate trophic level of the small aquatic fauna. The small marsh fishes, macroinvertebrates and herpetofauna form the link between the algal and detrital food web bases of the Everglades and the larger fishes, alligators and wading birds that feed upon them. Aquatic animal populations are currently diminished due to two factors related to water management. Reduction in the spatial extent of Everglades wetlands by half has

resulted in a proportional reduction in habitat of aquatic organisms, and changes in the hydrology in remaining wetlands has further reduced their populations.

In the freshwater Everglades, population densities of marsh fishes such as the golden topminnow (*Fundulus chrysotus*), bluefin killifish (*Lucania goodei*), sailfin molly (*Poecilia latipinna*), mosquitofish (*Gambusia affinis*), flagfish (*Jordanella floridae*) and small sunfish are directly proportional to the duration of uninterrupted flooding. This fish assemblage proliferates under extended periods of flooding and may reach maximum population densities only after five to six years of continuously flooded conditions in Shark River Slough. In adjacent areas of higher elevation marl marshes and rocky glades that tend to dry annually, survivors must repopulate each year after retreating into refugia that hold water through the dry season such as alligator holes, solution holes in exposed limestone, algal mats, and longer-hydroperiod marshes of Shark River Slough. The existing duration of uninterrupted flooding in Shark River Slough averages less than two years, compared to more than 15 years pre-drainage. In the marl marshes and rocky glades, where the duration of uninterrupted flooding currently averages only about three months compared to nearly ten months pre-drainage, the refugia that once enabled the survival of aquatic fauna during droughts now often dry completely, and repopulation requires longer distance migration from the longer-hydroperiod marshes of Shark River Slough which also dry frequently. Existing conditions thus keep the marsh fish populations of Shark River Slough and the marl prairies and rocky glades at perpetually low densities compared to pre-drainage conditions.

Aquatic macroinvertebrates live in close association with marsh fishes in the freshwater aquatic community. The amphipod (*Hyallela aztecus*), the freshwater prawn (*Palaemonetes paludosus*), the crayfish (*Procambarus alleni*), and the apple snail (*Pomacea paludosa*) represent ubiquitous and highly abundant processors of detritus and algae that must play key roles as prey species and in the cycling of energy and nutrients through the aquatic food webs of the Everglades and other south Florida wetlands. The crayfish is particularly important in the diet of white and glossy ibis. The apple snail is the sole food of the snail kite (*Rostrhamus sociabilis plumbeus*). The habitat requirements, life histories and population dynamics of these organisms remain largely unknown.

Also abundant in the freshwater aquatic community are amphibians and reptiles including the squirrel tree frog (*Hyla squirella*), green treefrog (*H. cenerea*), ranid frogs such as the pig frog (*Rana grylio*) and southern leopard frog (*R. utricularia*), legless siren (*Siren lacertina*) and amphiuma salamanders (*Amphiuma means*), swamp snakes, water snakes and cottonmouths (*Agkistrodon piscivorus*), and the red-bellied (*Pseudemys nelsoni*), and mud turtles (*Kinosternon subrubrum steindachneri* and *K. baurii*). Amphibia and their larvae represent important prey species for larger predatory fishes, alligators (*Alligator mississippiensis*) and wading birds. Turtles, snakes and amphiuma are commonly consumed by

alligators. The pig frog is commercially harvested for frog legs. The high numbers of herpetofauna in the Everglades, particularly of such ubiquitous and abundant species as the squirrel tree frog, suggest that they function as critical energy pathways in food webs. Anecdotal accounts of the Everglades from early this century describe a much greater abundance of amphibians and reptiles compared to densities observed today.

Included in the freshwater aquatic community of south Florida are the larger sport species such as the largemouth bass (*Micropterus salmoides*), sunfishes, black crappie (*Lepomis nigromaculatus*) and important non-sport predators such as Florida gar (*Lepisosteus platyrhincus*) and bowfin (*Amia calva*). Lake Okeechobee is renowned for the trophy bass from its littoral zone and for an abundant black crappie fishery. Largemouth bass also naturally inhabit the deeper-water sloughs and wet prairies of the Everglades, where they grow at a rate of one pound per year of uninterrupted flooding. Wet prairies, sloughs and alligator holes are also the natural habitat of gar and bowfin. Shortened hydroperiods in much of the Everglades in combination with compartmentalization presently confine larger bass mostly to canals, which provide a popular recreational fishery. Unfortunately, Everglades bass contain high body burdens of mercury, presumably through biomagnification in the food chain, which make them unsuitable for frequent human consumption. Restoration of hydroperiods in the Everglades should expand the canal fishery for the largemouth bass to the sloughs and wet prairies where it historically occurred, create new fisheries in water preserve area reservoirs, and displace some existing fisheries in canals that will be filled. Bass fisheries in remaining canals should be substantially improved due to their proximity to marshes with lengthened hydroperiods.

The American alligator is a keystone species in the Everglades. Holes that are excavated by alligators form ponds where aquatic fauna survive droughts, and mounds of sediment that are excavated from the holes create higher-elevation habitat upon which willow and other swamp forest trees grow. In addition to its keystone role in the creation of alligator holes, the American alligator is the top predator in the Everglades and feeds at various stages in its life on every level of the food chain, from small fishes to wading birds.. Everglades alligators construct nests from mounds of vegetation and organic sediment that they excavate from the holes. Eggs are laid at the beginning of the wet season at elevations in the nests that are not likely to be flooded as water levels rise throughout the remaining wet season. Under current conditions, alligators have abandoned the marl prairie and rocky glades landscape where they were once most abundant, and where aquatic fauna were dependent on alligator holes for survival through dry seasons, because shortened hydroperiods have rendered the marl prairie and rocky glades a mostly terrestrial system where the alligator can no longer survive. Presently alligators and their holes are found mostly in the Water Conservation Areas and Shark River Slough, although reproduction is suppressed there. Water level fluctuations and

impoundment effects in the Water Conservation Areas and regulatory water releases into Everglades National Park thwart the alligator's ability to lay their eggs at nest elevations that will not be flooded later in the wet season. The result is an increased frequency of drowned nests under current conditions.

In the brackish-water estuarine transition between the Everglades and Florida and Biscayne Bays, a low-salinity mangrove fish assemblage including the sailfin molly, topminnows, sheepshead (*Archosargus probatocephalus*), rainwater killifish, and small sunfishes achieves highest densities under conditions of freshwater and salinity less than five to eight parts per thousand. Under current conditions, decreased freshwater heads and flows upstream in the Everglades frequently allow elevated salinities above the optima for this fish assemblage and infrequently result in saltwater conditions in the estuarine transition. As a result, population densities of the small marsh fishes of the estuarine transition appear to be depressed and more erratic today in comparison to pre-drainage conditions.

The most conspicuous indicators of ecosystem health in the Everglades are the plummeting populations of wading birds, which are presently only ten percent of previous numbers of nesting birds, and which appear to continue to decline. The coastal nesting colony locations where most wood stork (*Mycteria americana*), white ibis (*Eudocimus albus*) and other wading bird species once nested are now abandoned. These locations are in the mangrove estuary of Florida Bay, where the juxtaposition of estuarine environments and persistent freshwater pools at the lower end of the Everglades once assured a dependable food supply throughout most breeding seasons. Particularly critical food bases include larger fishes at least in their second year of life for wood stork, and a wide variety of fishes, other vertebrates and invertebrates for other species, with a particular importance of crayfish to white ibis. These food bases are mostly contained in the freshwater marsh fish assemblage of the Everglades and the low salinity mangrove fish assemblage of the estuarine transition zone that are described above. Abandonment of the traditional coastal breeding colony locations by wading birds is largely attributed to depletion of these food bases in the southern Everglades. This depletion is due to abbreviated hydroperiods in Shark River Slough and the marl prairie/rocky glades, the loss of drought refugia in alligator holes in these regions, and the less desirable salinity regimes in the mangrove estuarine transition.

Under current conditions, most Everglades wading bird nesting colonies are located to the north in the Water Conservation Areas, in areas that were not traditional colony locations. Nesting birds appear to have been drawn to the Water Conservation Areas by persistent pools of water, and populations of prey species, at the lower end of each impoundment. Successful nesting there depends on the persistence of those pools, and on a steady water level recession to condense prey organisms and to provide suitable depth ranges for feeding, throughout dry seasons.

Unfortunately those conditions are not predictable under current operations of the Water Conservation Areas, and wading bird nesting success is low most years.

Another aspect of wading bird reproduction that is diminished under current conditions is the formation of "super colonies" of as many as 75,000 pairs of white ibis in coastal colony locations. Super colonies that traditionally nested in the coastal colonies have shifted to the Water Conservation Areas, where fewer numbers of breeding pairs have uncertain and relatively low reproductive success. Super colonies recur approximately every five to ten years. They coincide with the resumption of relatively normal annual rainfall and water levels during the first year following a drought. Causal factors of super colonies are poorly understood.

Roseate spoonbills (*Ajaia ajaja*) traditionally nested in eastern Florida Bay and fed upon smaller invertebrates in the low salinity coastal marshes of the Taylor Slough basin. Spoonbills have shifted colony locations to current nesting sites in central and western Florida Bay, presumably in response to declining food sources in their previous feeding grounds.

In addition to the abandoned coastal wading bird nesting colonies and depleted populations of low-salinity mangrove fishes, impacts to the mangrove estuarine transition due to diminished freshwater heads and flows upstream include degraded habitats for the American crocodile, migratory waterfowl, and nursery grounds of sport fishes and pink shrimp (*Penaeus duorarum*). Juveniles of the endangered American crocodile (*Crocodylus acutus*) seek low salinity areas of the mangrove estuary, which occur less frequently today, and their survival and growth is reduced at salinity levels above 25 parts per thousand, which occur more frequently today. The winter aggregations of more than 50,000 coots (*Fulica americana*), widgeon and other waterfowl that fed on beds of Chara and widgeon grass in the coastal lakes and basins no longer utilize these areas in large numbers since higher salinities have reduced the abundance of their food plants. Nursery ground suitability for juvenile sport fishes such as spotted seatrout (*Cynoscion nebulosus*), tarpon (*Megalops atlanticus*) and red drum (*Sciaenops ocellatus*) is diminished under the increased frequency of hypersaline conditions in the coastal basins. The same applies to pink shrimp in Whitewater Bay, which contribute to a multi-million annual Tortugas fishery (Sheridan, 1996). Spotted seatrout recruitment is adversely affected at salinity levels above 25 parts per thousand.

The white-tailed deer (*Odocoileus virginianus*) is widespread in most of the Everglades and the Big Cypress Basin. A healthy deer population persists in the Big Cypress basin. In the Everglades, the deer herd currently is higher than it was under pre-drainage conditions because it has benefited from lower water levels. However, during high water periods, massive mortality can occur when the deer are stranded on over-browsed tree islands, and starve. The restoration of the Everglades will reduce deer populations in the Everglades to densities closer to pre-

drainage levels, but it will also reduce mortality due to unnaturally high water events.

3.7 THREATENED, ENDANGERED AND STATE LISTED SPECIES

The U.S. Fish and Wildlife Service, by letters dated February 20, 1997 and April 8, 1998 identified 18 Federally listed plant and animal species that would likely be affected by Restudy alternatives within the study area (***Table 3-1***). Of the listed species, Critical Habitat has been designated for the West Indian manatee (*Trichechus manatus*), snail kite, Cape Sable seaside sparrow and American crocodile.

For a description of these critical habitat geographic designations and a complete species description, taxonomy, distribution, habitat requirements, management objectives, and current recovery status, refer to the draft Multi-Species Recovery Plan for the Threatened and Endangered Species of South Florida, Volume I (USFWS, 1998b) or the U.S. Fish and Wildlife Service endangered species web site at ***http://www.fws.gov/r9endspp/endspp.html***. For a complete listing of all the Federally listed threatened and endangered plant and animal species occurring or thought to occur within the study area, reference the above web site. The Florida Game and Fresh Water Fish Commission correspondence dated February 23, 1998 and December 14, 1998 provided information on state listed species likely to be affected by the Restudy or present within the study area (***Table 3-1*** and ***Appendix J***). For a detailed description of existing conditions for the 18 Federally listed species see ***Appendix J***.

TABLE 3-1
THREATENED, ENDANGERED & SPECIES OF SPECIAL CONCERN
PLANTS AND ANIMALS
LIKELY TO BE AFFECTED BY THE C&SF RESTUDY

Scientific Name	Common Name	USFWS	GFC
Trichechus manatus	West Indian Manatee	E*	E
Felis concolor	Florida panther	E	E
Rostrhamus sociabilis plumbeus	Snail kite	E*	E
Mycteria americana	Wood stork	E	E
Ammodramus maritimus mirabilis	Cape Sable seaside sparrow	E*	E
Crocodylus acutus	American crocodile	E*	E
Ammodramus savannarum floridanus	Florida grasshopper sparrow	E	E
Picoides borealis	Red-cockaded woodpecker	E	T
Haliaeetus leucocephalus	Bald eagle	T	T
Polyborus plancus	Audubon's crested caracara	T	T
Drymarchon corais couperi	Eastern indigo snake	T	T
Aphelocoma coerulescens	Florida scrub-jay	T	T
Cucurbita okeechobeensis	Okeechobee gourd	E	
Amorpha crenulata	Crenulate lead-plant	E	
Euphorbia deltoidea	Deltoid spurge	E	
Galactia smallii	Small's milkpea	E	
Polygala smallii	Tiny polygala	E	
Euphorbia garberi	Garber's spurge	T	
Falco sparverius paulus	American kestrel(SE subsp.)		T
Grus canadensis pratensis	Florida sandhill crane		T
Mustela vison evergladensis	Everglades mink		T
Sciurus niger avicennia	Big Cypress fox squirrel		T
Ursus americanus floridanus	Florida black bear		T
Rana capito	Gopher frog		SSC
Gopherus polyphemus	Gopher tortoise		SSC
Pituophis melanoleucus mugitus	Florida pine snake		SSC
Aramus guarauna	Limpkin		SSC
Egretta caerulea	Little blue heron		SSC
Egretta thula	Snowy egret		SSC
Egretta tricolor	Tricolored heron		SSC
Eudocimus alba	White ibis		SSC
Speotyto cunicularia	Burrowing owl		SSC
Blarina carolinensis shermani	Shermans short-tailed shrew		SSC
Podomys floridanus	Florida mouse		SSC
Sciurus niger shermani	Sherman's fox squirrel		SSC
Liguus fasciatus	Florida tree snail		SSC

E Endangered
T Threatened
* Designated Critical Habitat
SSC State listed Species of Special Concern

3.8 WATER MANAGEMENT

For this section, the Central and Southern Florida Project has been broken down into four hydrologically related geographical areas consisting of: (1) the Kissimmee River – Istokpoga Basin; (2) the Lake Okeechobee and Everglades Agricultural Area; (3) the Water Conservation Areas, Everglades National Park, and Everglades National Park - South Miami-Dade Conveyance Canals; and (4) the East Coast Canal watersheds.

3.8.1 Kissimmee River – Istokpoga Basin

The Kissimmee River – Lake Istokpoga Basin portion of the project includes most of Osceola and Okeechobee and parts of Orange, Polk, Highlands, and Glades Counties. It is bounded on the north by the lakes of the Orlando area, on the west by the Peace River watershed, on the south by Lake Okeechobee and on the east by the Upper St. Johns River Basin and the Taylor Creek-Nubbin Slough Basin. The project purposes include flood control, water supply, navigation, and fish and wildlife. The project protects the lands adjacent to the lakes and along the Kissimmee River from frequent and prolonged flooding. It provides water supply for agricultural uses in the area in and around the lakes and the Kissimmee River. It also provides for navigation on the Kissimmee River and all lakes in the Middle and Upper Kissimmee River Basin. Locks are provided at control structures on the main watercourse between east Lake Tohopekaliga and Lake Okeechobee. Boatlifts are provided at all other structures. Maintaining lake stages at a desirable level for fish and wildlife and for recreational purposes is also important.

The Kissimmee Basin is an integrated system of lake storage capabilities and structure outlet capacities. The Upper Kissimmee Basin structures are operated according to regulation schedules. The regulation schedule essentially represents the seasonal and monthly limits of storage that guide the regulation of the project for the planned purposes. The regulation schedules vary from high stages in the late fall and winter to low stages at the beginning of the wet season. The lakes are drawn down in the spring to provide flood control storage and for fish and wildlife enhancement. The minimum levels are set to provide for sufficient flood control storage and navigation depths. The amount of seasonal fluctuation was derived by determining the effect of various water levels on the flood control, low water regulation, groundwater, fish and wildlife, and recreation. Runoff during the wet season is stored for use in the dry season. The regulation schedules take into account these varying, and often, conflicting purposes.

The Lake Istokpoga Project works were primarily designed to protect lands adjacent to the lake from flooding by lake waters, and provide water supply for agricultural use in areas around the lake and in the Indian Prairie area. At the

same time, project works maintain the lake at a desirable level for fish and wildlife, navigation, and for recreational purposes.

The project has decreased the area inundated by major floods with floodwaters being passed for storage in Lake Okeechobee. It also prevents longer duration of low to no-flow water conditions during prolonged periods of drought in the lower basin. This is accomplished by conserving or storing waters within both the controlled pools behind the existing structures and in the channelways for drought protection. Other effects include year-round small boat navigation of the system from Lake Tohopekaliga to Lake Okeechobee with boat access to the Kissimmee River for fishing and recreation. The C-38 pools add to the total volume of water available for aquatic species support. The C&SF Project has, in effect, stabilized lake and river levels, removing both the highest (flood) and lowest (dry down) levels providing year-round navigability.

3.8.2 Lake Okeechobee and Everglades Agricultural Area

Lake water levels in Lake Okeechobee are regulated by a complex system of pumps, spillways and locks. The regulation schedule attempts to achieve the multiple-use purposes as well as provide seasonal lake level fluctuations. The schedule is designed to maintain a low lake stage to provide both storage capacity and flood protection for surrounding areas during the wet season. The schedule is also a guide for the management of high lake stages that might threaten the integrity of the Herbert Hoover Dike and thereby risk flooding of downstream lands. During the winter, lake levels may be increased to store water for the upcoming dry season. The general plan of operation for Lake Okeechobee is based on the following: 1) flood protection from lake waters and hurricane-driven wind tides for lands adjacent to the lake; 2) maintenance of an 8-foot navigation channel across Lake Okeechobee, as part of the Okeechobee Waterway and; 3) storage of water to meet the requirements of the agricultural area south and east of the lake.

Flood control works on Lake Okeechobee consist of a system of about 1,000 miles of encircling levees, designed to withstand a severe combination of flood stage and hurricane occurrence, plus the regulatory outlets of St. Lucie Canal and the Caloosahatchee River. The design discharge of Moore Haven Spillway is 9,300 cfs; that of St. Lucie Spillway is about 16,000 cfs. Following removal of local runoff from the agricultural areas south of the lake, an additional regulatory capability of several thousand cfs is available through the Miami, North New River, Hillsboro, and West Palm Beach Canals by pumping into the three Water Conservation Areas. The crest elevation of the levee system surrounding the lake ranges from 32 to 45 feet, NGVD. The likelihood of overtopping the levees from excess storage is almost non-existent. Possible flooding due to overtopping of levees within the Herbert Hoover Dike system is limited to short duration events involving wave runup in

addition to hurricane-induced storm surge. The likelihood of such events is remote and the expected extent of flooding is minimal.

3.8.3 Water Conservation Areas

The primary purposes for the Water Conservation Areas and their appurtenant levees, canals, structures, and pump stations include flood control, water conservation, prevention of salt-water intrusion, recreation, preservation of fish and wildlife, and water supply for Everglades National Park. The Water Conservation Areas are completely contained by levees, except for about seven miles on the west side of Water Conservation Area-3A, which has a tieback levee. There are also levees on the east side of the East Everglades, which protect the agricultural and industrial areas, which otherwise would have been short hydroperiod wetlands, from inundation. This whole region is managed with a system of canals, multiple pump stations, and control structures. The main canals are West Palm Beach Canal, Miami Canal, Bolles and Cross Canals, North New River Canal, South New River Canal, Hillsboro Canal, and Tamiami Canal.

The Water Conservation Areas provide a detention reservoir for excess water from the Everglades Agriculture Area and parts of the East Coast region, and for flood discharge from Lake Okeechobee to the sea. The Water Conservation Areas provide levees to prevent Everglades floodwaters from inundating the east coast urban areas; provide a water supply for east coast areas and Everglades National Park; improve the water supply for east coast communities by recharging underground freshwater reservoirs; reduce seepage; ameliorate salt-water intrusion in coastal wellfields; and provide mixed quality habitat for fish and wildlife in the Everglades.

The regulation schedules contain instructions and guidance on how project spillways are to be operated to maintain water levels in the Water Conservation Areas. The regulation schedules essentially represent the seasonal and monthly limits of storage which guides project regulation for the planned purposes. The schedules vary from high stages in the late fall and winter to low stages at the beginning of the wet season. This seasonal range permits the storage of runoff during the wet season for use during the dry season. In addition, it serves to maintain and preserve plant cover in the Water Conservation Areas, which is essential to fish and wildlife and the prevention of wind tides. Regulation schedules must take into account various, and often conflicting, purposes. Conceptually, reservoir storage is commonly divided into the inactive zone, the water supply (conservation) zone, and the flood control zone. The distribution of water between the flood control and water supply zones varies seasonally in the Water Conservation Areas. The regulation schedules for Water Conservation Area 1, Water Conservation Area 2A, and Water Conservation Area 3A include a minimum water level, as measured in the borrow canals, below which water releases are not

permitted unless water is supplied from another source. Note that this does not mean that a minimum stage is maintained in the Water Conservation Areas. When water levels fall below the minimum levels, transfers from Lake Okeechobee or upstream Water Conservation Areas are made to meet water supply demands.

3.8.4 East Coast Canal Watersheds

The East Coast Canals are the flood control and outlet works that extend from St. Lucie County southward through Martin, Palm Beach and Broward Counties to Miami-Dade County, a distance along the Atlantic Coast of about 170 miles. The East Coast Canal watersheds encompass the primary canals and water control structures located along the Lower East Coast of Florida and their hydrologic basins. The main design functions of the project canals and structures in the East Coast Canals area are to protect the adjacent coastal areas against floods; store water in conservation areas west of the levees; control water elevations in adjacent areas; prevent salt-water intrusion and over drainage; provide freshwater to Biscayne Bay and provide water for conservation and public consumption. There are 40 independently operated canals, one levee, and 50 operating structures, consisting of 35 spillways, 14 culverts, and one pump station. The project works to prevent major flood damages. However, due to urbanization, the existing surface water management system now has to handle greater peak flows than in the past.

The South Miami-Dade Conveyance System provides a way to deliver water to areas of south Miami-Dade County. This canal system was overlain on top of the existing flood control system. Many of these canals are used to remove water from interior areas to tidewater.

Areas become flooded during heavy rainfall events due to antecedent conditions that cause saturation and high runoff from both developed and undeveloped areas. When areas become flooded, excess water is removed through the canals. Automatic controls installed on some of the water control structures allow the canal levels to fall into a lower range which provides limited extra storage in the lakes and canals. Thus, during a heavy rainfall event, extra storage is available for the secondary canal system to drain into the larger canals. The automatic controls also allow for frequent gate changes that keep the water levels in the safe range. Saltwater intrusion has declined considerably at coastal structures since the installation of salinity dams downstream and the placement of salinity monitoring sensors near the structures. Damage to agriculture, citrus, and pasturelands due to flooding has been reduced as a result of the effective drainage capabilities of the canals.

The project works maintain optimum stages for the purposes of flood control, water supply, groundwater recharge, and prevention of salt water intrusion. The coastal canals and control structures between St. Lucie and Miami-Dade Counties

are designed to permit rapid removal of floodwaters from their immediately adjacent drainage area. The degree of flood protection provided by outlet capacity is dependent on whether the protected area is urban or agricultural. Maximum rates of removal vary from 40-percent to 100-percent Standard Project Flood. The canals and structures are regulated automatically or manually, as designed, in accordance with the optimum water control and design elevations, with the exception of hurricane or tropical storm regulation.

The network of canals and control structures provides for water and salinity control in the area. Wellfields, which are the source of municipal water supplies, are significantly recharged by water from the Water Conservation Areas. Water stored in the Water Conservation Areas can be used to maintain groundwater levels in the coastal area for public water supply, to irrigate the vast agricultural areas interspersed within the project area, and to maintain a freshwater head along the Lower East Coast for salinity control.

The construction and operation of the East Coast Canals for flood protection and the lowering of the ground water table on the east coast ridge significantly affected freshwater deliveries to Biscayne Bay and Biscayne National Park. The patterns of freshwater discharge changed from long, slow releases over a broad front to "pulse" releases from canals following rain events.

3.9 WATER QUALITY

Water quality in the study area is significantly influenced by development. The C&SF Project has led to significant changes in the landscape by opening large land tracts for urban development and agricultural practices, and by the construction of extensive drainage networks. Natural drainage patterns in the region have been disrupted by the extensive array of levees and canals such that nonpoint source (stormwater) runoff and point sources of pollution (wastewater discharges) are now entering the system in many areas. Several pollutants of concern in the study area have been identified. These include:

- Metals - mercury, copper, cadmium, lead, zinc, arsenic, and tributyltin (TBT)
- Pesticides - DDT and derivatives, atrazine, simazine, ametryn, endosulfan compounds, ethion, bromacil, 2,4-D, aldecarb, and fenamiphos
- Nutrients - phosphorus, nitrite/nitrate, and ammonia/un-ionized ammonia
- Biologicals - fecal coliforms and pathogens, and chlorophyll-a
- Physical parameters - pH, dissolved oxygen, conductivity, turbidity, oil and grease, temperature, and salinity
- Other constituents - Polycyclic Aromatic Hydrocarbons (PAHs), dioxins and furans, sulfate, chloride, Polychlorinated Biphenyls (PCBs), and Volatile Organic Carbons (VOCs).

Of this list, phosphorus, pesticides and mercury are considered to be the most important water quality pollutants of the region and are discussed below. A much more thorough discussion of existing water quality conditions including the Federal, State, and Tribal water quality regulations and standards are provided in ***Appendix H.***

Phosphorus: Historically, south Florida waters were low in nutrients (oligotrophic). Due to human activities including the ditching and draining of wetlands and the expansion of agriculture waterbodies from the Kissimmee River southward have become nutrient-enriched to various degrees. The farming areas surrounding Lake Okeechobee in general have contributed to elevated nutrients in the Kissimmee River, Lake Okeechobee, the Caloosahatchee River, and the Everglades. In addition, urban storm water runoff is another potential source of phosphorus to the Everglades and south Florida coastal systems.

In general, the trend for phosphorus concentrations is a decrease from north (Kissimmee River and Everglades Agricultural Area) to south (Everglades National Park) since there are major anthropogenic sources in the agricultural areas in the north. Nutrient removal from marsh water is due to the natural water quality treatment processes associated with south Florida wetlands, notably the Everglades. According to the Florida Surface Water Improvement and Management (SWIM) Act Plan for Lake Okeechobee (SFWMD, 1997f), the highest average phosphorus concentrations (up to over 700 parts per billion (ppb) are measured in waters discharged from the Lower Kissimmee River (S-65D Basin = 770 ppb), Taylor Creek/Nubbin Slough (S-154 Basin = 610 ppb), and the Everglades Agricultural Area (East Beach Drainage District = 560 ppb). The lowest concentrations (about 10 ppb) in the study area are reported for marsh stations within the Everglades National Park (USGS, 1996).

Elevated phosphorus loading of waterbodies and the resulting increased water phosphorus concentrations (eutrophication) may have various ecological effects. These effects may include increased primary productivity, loss of water column dissolved oxygen, algal blooms, changes in vegetation and biodiversity, and accumulation of phosphorus in sediments and muck. The significance of such phosphorus loading may be the reduction or loss of a waterbody's habitat and/or recreational value.

Pesticides: An extensive array of pesticides is applied to (or persists in) south Florida waters, sediments and/or soils. The south Florida region is unique in that a very large and sensitive ecosystem exists in the midst of an ever growing urban population and an extensive and intensive agricultural production area. A variety of pesticides are used in this area for a number of different reasons. Major uses are ground and/or aerial applications related to agricultural production, mosquito

control, aquatic plant growth in local waterways, golf course maintenance, and lawn and vegetation maintenance. Pesticides used in these ways are effective in controlling the pests of concern. However the use of pesticides may also pose possible threats to the sensitive ecosystems and human health in Florida. This is due to the intense year-round use of pesticide compounds, coupled with intense storm events, the shallow water tables and the ever-increasing urban sprawl into previously undisturbed areas.

Mercury: Mercury is a toxic heavy metal. Levels of mercury in water, animal tissue, sediments, periphyton, air, and soil have been shown to be elevated in certain areas of south Florida. However, the sources, distribution, magnitude, transport, transformations and pathways of mercury through the Everglades ecosystem are poorly understood. Among the possible mercury sources in south Florida are natural mineral and peat deposits (Rood et al., 1995), and atmospheric deposition from global, regional and local (e.g., fossil-fuel-fired electrical generating plants, municipal waste incinerators, and medical waste incinerators) sources. Sources of mercury are now believed to be primarily from atmospheric deposition. Once elemental mercury is methylated by microbial action, it becomes biologically available for bioaccumulation at various levels of the food chain and for biomagnification up the food chain to top carnivores such as the Florida panther.

3.9.1 Regional Overview of Water Quality Conditions

Under Section 303(d) of the Federal Clean Water Act (CWA) states develop Total Maximum Daily Loads (TMDLs) for their water bodies that are not meeting designated standards under technology-based controls for pollution. For the study area, over 160 priority waterbodies/segments were listed by Florida Department of Environmental Protection. Using basin names designated in the annual Florida Department of Environmental Protection 305(b) reports (prepared for the U.S. Environmental Protection Agency pursuant to Section 305(b) of the Federal CWA), the approximate number of priority listings by basin were as follows.

- Kissimmee River Basin (29)
- Lake Okeechobee (12)
- Caloosahatchee River Basin (11)
- Everglades-West Coast or Big Cypress Basin (14)
- Southeast Florida Basin (95)
- Florida Keys (0).

Lake Okeechobee is at the center of the south Florida drainage system, receiving flow from the Kissimmee River Basin, and to a lesser extent from Everglades Agricultural Area backpumping. It discharges east through the C-44 Canal into the St. Lucie River Estuary, west through the Caloosahatchee River via the C-43 Canal, and south through four major canals into the Water Conservation

Areas. The Lake may be considered an historically nutrient rich water body that is becoming hypereutrophic, due primarily to nutrient inputs from the Kissimmee River and the Taylor Creek/Nubbin Slough Basins. Water quality conditions in the upper Kissimmee River appear to be improving, primarily due to re-routing of wastewater flows from the river to reuse and ground-water discharge sites. However, large quantities of nutrients are still discharged from Lake Tohopekaliga to Lake Kissimmee and other downstream areas. Water quality improves from Lake Kissimmee to near Lake Okeechobee, where the channel flows mostly through unimproved rangeland; however, pollutant loadings significantly increase as cattle and dairies grow more numerous Lake Okeechobee. The lake's total phosphorus levels have doubled in the last 20 years, due in large part to agricultural runoff. This same runoff also has contributed to frequent and widespread algal blooms and at least one major fish kill.

Even with the extensive pollutant abatement programs implemented in Lake Okeechobee watersheds during the past 15 years (i.e., reduction of Everglades Agricultural Area backpumping, dairy buyouts, the Florida Department of Environmental Protection Dairy Rule, the South Florida Water Management District Works of the District Regulatory Program), recent lake water nutrient concentrations and loads show no substantive signs of improvement. Further, because the lake's phosphorus is internally recycled, and a vast reservoir of the nutrient is stored in lake sediments as well as the lake's wetlands and watershed canal sediments, phosphorus levels in lake waters may not reach acceptable levels for many decades.

The Caloosahatchee River forms the major basin to the west of the lake. Water quality conditions are degraded in the upper and lower areas of the basin, due to agricultural and urban runoff, respectively. The channelized section of the river also shows degraded water quality conditions, due to agricultural inputs, as compared to tributaries lying in less developed areas of the basin. Problems associated with the degraded areas of the basin are typified by low dissolved oxygen levels, elevated conductivity, and decreased biodiversity. Conditions in the urbanized sections of the basin are influenced by nonpoint storm water flows, and are manifested in the river by elevated chlorophyll levels, algal blooms, periodic fish kills, and low dissolved oxygen levels.

Extensive agricultural Best Management Practices have been implemented in the Everglades Agricultural Area in the past several years which have reduced the phosphorus load leaving the Everglades Agricultural Area; however, this area remains a primary source of pollutants for the Water Conservation Areas. The Water Conservation Areas are the remaining wetlands in the northern section of the Everglades system. These areas have been isolated from contiguous lands by a series of levees and pump stations. Water moving south from Lake Okeechobee and the Everglades Agricultural Area is pumped into the Water Conservation Areas

canals, effectively making these areas act as nutrient filters. The highly altered hydroperiod, resulting from the levees and pump operations, may exacerbate water quality conditions in the Water Conservation Areas, as evidenced by a general degradation of water quality in the areas along the canals and adjacent to pump stations, as compared to conditions in the central portions of the basins. Construction of the Stormwater Treatment Areas upstream of the Water Conservation Areas is expected to improve water quality conditions in the Water Conservation Areas through time.

Water quality conditions in the Upper East Coast are generally good in less developed areas of the basin. However, conditions are degraded in urbanized areas and along the extensive network of canals that drain this area. The worst water quality conditions in the basin are reported in the St. Lucie River and the canals leading from the Everglades Agricultural Area. Other major problem areas are found in Five-Mile and Ten-Mile Creeks (in the areas near Port St. Lucie), the main channel of North Fork in Port St. Lucie, and Manatee Pocket (a small embayment on the St. Lucie Estuary). Although the Savannas State Preserve, a 15-mile-long freshwater marsh between Ft. Pierce and Stuart, has fairly good water quality, mercury concentrations in fish tissue were high enough to warrant a no-consumption advisory for largemouth bass. The major sources of pollution in this basin are urban runoff, agricultural and rangeland runoff, boat discharges, and sewage overflows.

Waterbodies in the Lower East Coast Region are seriously degraded in the heavily urbanized areas, including the numerous man-made canals associated with the coast and drainage canals. For example, water quality in Lake Worth is good near the inlet and fair to good north of the inlet, but poorer to the south, especially in the area between the inlet and the West Palm Beach Canal (C-51 Canal). Water quality in Lake Worth improves again near the South Lake Worth Inlet. A small section of the North Fork of the Loxahatchee River has low dissolved oxygen levels, and in the last decade, seagrass beds in the estuarine portion of the Loxahatchee River have declined dramatically. Canals and waterbodies in and around Ft. Lauderdale are particularly degraded by urban runoff and historical wastewater treatment discharges, and by agricultural runoff in the westernmost areas on the canals. Problems associated with these pollutants are manifested by the dense growth of undesirable aquatic vegetation, low overall biological diversity, and the occurrence of exotic plants and animals. The New River and Miami River run through highly urbanized areas of Ft. Lauderdale and Miami, respectively. Both are polluted by improperly functioning septic tanks, discharges from vessels, industrial activities, improper sewer connections, and storm water runoff. These discharges result in high nutrient concentrations, high coliform bacteria counts, and high concentrations of heavy metals such as tin, copper, zinc, and chromium in sediments at all marina sites. Biscayne Bay has good water quality in the open

water areas of its central and southern portions, and degraded conditions in its northern portion north of the Miami River.

In the central Everglades, phosphorus concentrations entering the Everglades National Park were lower in 1997 (Walker, 1998: internet) than the interim and long term limits established by the 1992 Settlement Agreement. While no significant trends in annual average mercury concentrations in water, sediment, or fish have been observed for the past five years, mercury concentrations in fish tissue were high enough to warrant a no-consumption advisory for largemouth bass throughout most of the eastern two thirds of the Everglades National Park, and a recommendation of limited consumption for the southeast corner of the Park. The best water quality conditions in the Everglades National Park were found in the central Shark River Slough and along the coastal regions of the basin.

Some parts of Florida Bay have experienced a massive seagrass and mangrove die-off during the late 1980's and early 1990's that likely stems from a lack of circulation, high water temperatures, and increased levels of salinity. Water diverted into the Lower East Coast primary canal network has reduced freshwater flows, and the salinity of bay water has been recorded as high as 70 parts per thousand. The 1997 Everglades Annual Report states that for 1997, the highest observed salinity levels occurred in Whipray Basin, and ranged from 40.6 parts per thousand to 42.3 parts per thousand (water conditions in the bay are considered hypersaline when salinity exceeds 35 parts per thousand). Hypersaline conditions were observed throughout most of the western portion of the bay during the dry season; however, they decreased below hypersaline levels once freshwater inputs increased in June 1997.

Water quality conditions in the Keys are generally good in areas open to the Atlantic or Gulf. However, many nearshore areas, man-made canals and marinas have water-quality problems that are exacerbated by poor circulation. Most of these problems are localized and generally can be attributed to wastewater plants and small "package plants" discharging to poorly flushed canals; septic tanks and cesspools; marinas lacking facilities to pump out waste from boats; fish processors; and storm water runoff, especially into the canals.

3.9.2 Groundwater Conditions

Ground water in south Florida consists of the surficial Biscayne Aquifer and the Floridan Aquifer. Both are critical to the ecology and economy of south Florida. The Biscayne Aquifer has been classified as a Sole Source Aquifer under the Federal Safe Drinking Water Act based on the aquifer's susceptibility to contamination and the fact that it is a principal source of drinking water. The Floridan Aquifer system is one of the most productive aquifers in the world and is a multiple-use aquifer system. Where it contains freshwater, it is the principal source

of water supply. In several places where the Floridan Aquifer contains saltwater, such as along the southeastern coast of Florida, treated sewage and industrial wastes are injected into it.

Because the Biscayne Aquifer is highly permeable and is at or near the land surface in many locations, it is readily susceptible to groundwater contamination. Major sources of contamination are saltwater intrusion and infiltration of contaminants carried in canal water. Additional sources include direct infiltration of contaminants, such as chemicals or pesticides applied to or spilled on the land, or fertilizer carried in surface runoff; leachate from landfills, septic tanks, sewage-plant treatment ponds; and wells used to dispose of storm water runoff or industrial waste.

Numerous hazardous waste sites (e.g., Superfund and Resource Conservation and Recovery Act (RCRA) sites) have been identified in the area underlain by the Biscayne Aquifer. Remedial action to clean up existing contamination is underway at many of these sites. Waste management practices are generally monitored to prevent further contamination. Additional information on groundwater conditions and contamination in south Florida is presented in ***Appendix H and K***, including specific Superfund (National Priority List: NPL) and RCRA hazardous waste sites in south Florida. Trichloroethylene (TCE) and vinyl chloride are examples of ground-water contaminants of concern.

3.10 WATER SUPPLY

One of the primary functions of the C&SF Project is to provide a highly-efficient flood control system designed to keep urban and agricultural areas dry in the wet season by discharging excess water to tide or into the Water Conservation Areas and Everglades National Park. Rapid wet season flood releases, coupled with the lack of retention in Lake Okeechobee, the reduced area of northern historical sawgrass plains, and loss of the eastern peripheral wetlands and sloughs, have severely reduced storage within the system causing excessive dry season demands on the regional system. The sawgrass plains, for example, once stored and slowly passed on much of the water that overflowed from Lake Okeechobee. Today, a large portion of the sawgrass plains habitat that was converted to agriculture within the Everglades Agricultural Area quickly passes excess runoff to the Water Conservation Areas and the coast during the wet season. Releases of Lake Okeechobee water are then periodically necessary to meet dry season demands. The reduction of storage over multiple years, not the lack of water, is a problem.

Minimum stages are maintained in Lower East Coast canals, principally to provide the volume of water needed to protect the Biscayne Aquifer from saltwater intrusion, a major threat to this water resource. The head created in the canals

raises groundwater levels, recharging the aquifer and the urban wellfields. During the wet season, wellfields are recharged by local rainfall and by the regional system that provides ongoing seepage from the Water Conservation Areas and the canals. During the dry season, they are more dependent on the regional system. Unfortunately, during the wet season, "excess" storm water is passed through the canals and out to tide, when it should be stored and used during the next dry season. Without sufficient storage, it has been difficult to have water available during the dry season without causing flooding during the wet season.

Water users within the urban areas argue that the Lower East Coast is largely self-sufficient and efficient because the groundwater seeping through the Lower East Coast would eventually reach coastal waters were it not withdrawn by the utilities. The South Florida Water Management Model illustrates how this works. As demands increase, the volume of water that reaches coastal waters decreases. In the South Florida Water Management Model, at Snake Creek, north of Miami, 121,000 acre-feet of water were lost through groundwater seepage during the wet season in the 1995 base. That amount decreased to 114,000 acre-feet in the 2050 base as urban water supply demand increased. In the Miami River, in the 1995 base, over 192,000 acre-feet were unrecoverable (wet and dry season total). In the 2050 base, only 121,000 acre-feet were unrecoverable.

Others argue that the urban area is far from self-sufficient. The pattern described above occurs during wet seasons and during normal rainfall years. During extremely dry years, no water reaches the coast and the urban wellfields depend heavily on deliveries from the Water Conservation Areas (including the ongoing seepage from these areas) and Lake Okeechobee via the primary canals for water supplies. Even during normal dry seasons when flood releases are minimal, the high demands on the system from urban water supply may be withdrawing water from the natural environment that should be kept in the system for late winter and spring biological rejuvenation. In addition, during drought years, the urban and agricultural areas create additional demands as the need for irrigation increases. Also, a significant percentage of water consumed is used for landscape maintenance, primarily watering lawns from shallow wells.

Another concern is that, at present, the flow of water along the eastern protective levee is from the wetlands to the coast. Keeping the water levels high west of the Atlantic Coastal Ridge, and keeping levels low to the east of it, results in large groundwater losses from the remnant Everglades throughout the year. This situation has also reduced the coastal groundwater flows into estuaries like Biscayne Bay and has made it necessary to import regional water to the Lower East Coast to maintain adequate coastal groundwater levels to prevent saltwater intrusion.

Due to efficiency in application, the amount of water needed to recharge urban wellfields is small compared to the tremendous volumes needed to prevent saltwater intrusion. Preventing saltwater intrusion is important for several reasons. For example, if significant saltwater intrusion occurred even once, the easternmost wellfields would be contaminated indefinitely and would be replaced with wells further west. This situation has already occurred in Metro-Miami-Dade County.

Although significant, the amount of water needed to prevent saltwater intrusion is much less than the wet season coastal releases. It is possible that those flows alone, if captured and stored, would be more than sufficient to maintain the dry season salinity barriers without the need to take water from the natural system. Also, storing coastal outflows in the lower east coast region and maintaining higher groundwater levels along the coastal ridge would allow large quantities of regional water to remain in the C&SF system and to be used for dry-season environmental benefits.

Within the Lower East Coast, there are also ecological benefits in maintaining groundwater levels. Lower groundwater levels can and have caused serious negative effects on estuaries and coastal and freshwater wetlands. Biscayne Bay for example, has suffered the consequences of both ground and surface water losses, including increased salinity, lower visibility, and lower water quality. In Miami-Dade, Broward and Palm Beach Counties, lowered groundwater levels have caused wetland desiccation and produced shifts in vegetation types.

3.11 SOCIO-ECONOMICS

Florida's economy is characterized by strong wholesale and retail trade, government and service sectors. The economy of south Florida is based on services, agriculture, and tourism. Florida's warm weather and extensive coastline attract vacationers and other visitors and help to make the state a significant retirement destination for people from all over the country.

The 16 south Florida counties that make up the study area had a 1990 population of 6.3 million, accounting for nearly half (about 49 percent) of Florida's total. This share has changed very little over the past 20 years and recent U.S Department of Commerce projections predict it will remain stable over the next 50 years. Over 60 percent of this south Florida population is in the three Lower East Coast Counties of Palm Beach, Broward, and Miami-Dade. The study area population is expected to reach over 11 million by 2050, with the Lower East Coast population expected to reach over 6.9 million by then.

Slightly over half of Florida's employment and earnings takes place in the study area. Nearly two thirds of this is concentrated in the populous Lower East Coast three-county area. Excluding the northernmost counties of Polk, Orange, and Osceola, which are technically part of the study area, but which are outside the main focus of the Restudy, the tri-county Lower East Coast area accounts for about 80 percent of the regional aggregate socio-economic activity with in the study area.

Employment and income in the south Florida study area have continued to grow in recent decades faster than the national average. Growth, though slower than that of the Lower East Coast, has been significantly greater in the southwest counties and the Florida Keys (taken as a group--Monroe, Collier, Hendry, Lee, and Charlotte), and in the Counties around Lake Okeechobee (Glades, Highlands, Martin, Okeechobee, and St. Lucie) than in the northernmost counties of the study area.

3.12 LAND USE

The existing use of land within the study boundaries varies widely from agriculture to high-density multi-family and industrial urban uses. A large portion of south Florida remains natural, although much of it is disturbed land. The dominant natural features are the federally protected Everglades National Park, Biscayne National Park, and Big Cypress National Preserve at the southernmost tip of the peninsula, Lake Okeechobee, Biscayne Bay, the state protected Water Conservation Areas in the westernmost reaches of the Lower East Coast counties, and remnant freshwater and coastal wetland and upland systems within and adjacent to the developed areas along the coasts. Generally, urban development is concentrated along the lower east coast from Palm Beach County to Miami-Dade County, in the central Florida / Orlando area, and on the Lower West Coast from Fort Myers to Naples.

Most of the interior of the study area is in agricultural use, which includes sugarcane (the dominant crop) and vegetable farms in the Everglades Agricultural Area of western Palm Beach County and Hendry County; the Agricultural Reserve Area of Palm Beach County; and the south Miami-Dade agricultural area where vegetable crops dominate, especially tropical varieties. There are citrus groves in every county, but citrus is concentrated in St. Lucie and Martin counties on the east coast and Hendry, Highlands, Collier, and Glades Counties on the west. Cattle and dairy farms predominate in Glades, Highlands, and Okeechobee Counties.

In the northern portion of the system, around Orlando, tourism and its attendant service-oriented land uses (for example, hotels/ motels, convenience stores, souvenir shops) make up a significant portion of the landscape. Agriculture, however, continues to play an important role in the region, with over two million

acres being farmed, half of which is pastureland. The area surrounding Lake Okeechobee, is largely rural, with agriculture the prevailing land use. There are over 700,000 acres of irrigated farm land in the Everglades Agricultural Area south of the lake. Farm products produced there include sugarcane, the predominant crop, rice, row crops, and sod. There is also extensive pastureland both west and north of the lake. Directly south of the Everglades Agricultural Area lie the Water Conservation Areas. The Water Conservation Areas cover about 878,080 acres and consist mainly of sawgrass marshes and tree islands. The Water Conservation Areas were created by the 1948 C&SF Project for the conservation of water supplies for the Lower East Coast.

The Upper East Coast includes St. Lucie and Martin Counties; the landscape is dominated by agricultural uses. Significant natural resources, the St. Lucie Estuary and Indian River Lagoon, are also contained within this area. Urban land use, which makes up 17 percent of the Upper East Coast, is mainly concentrated along the seaboard coastal and lagoon shorelines. The Lower East Coast extends approximately 100 miles through the coastal portions of Palm Beach, Broward, and Miami-Dade Counties. As the most densely populated subregion in the state, the Lower East Coast is home to one third of the state's population, more than 4.5 million people. The subregion is primarily an urban megalopolis, but it also contains substantial agricultural acreage, particularly in southwestern Miami-Dade County (90,000 acres) and western Palm Beach County (29,000 acres). Rapid population growth and land development practices have resulted in notable western urban sprawl; the predominant land use is single-family residential. The once significant rural population in the western areas of Broward County has practically disappeared, resulting in an urbanized makeup in population. Miami-Dade and Palm Beach Counties are not far behind.

The Florida Keys are made up of over 1,700 islands that encompass approximately 100 square miles, and contains the largest coral reef system in the United States. While a majority of Monroe County is designated as conservation land, due to the land falling within either Everglades National Park, the Big Cypress National Preserve, or the National Key Deer Refuge, land use is primarily either residential or geared towards supporting the region's main industry (tourism). Monroe County's fragile natural resources and vulnerability caused the State of Florida to designate the area as an Area of Critical State Concern in 1975; such designation is intended to protect such resources from degradation by strictly regulating development.

The southwestern counties of Collier and Lee are the fastest growing in terms of population in the state. Population growth is mainly due to the in-migration of retirees, not a high birthrate. The coast has become highly urbanized, with development spreading eastward into agricultural and natural lands. Agriculture is however, a major industry, especially in Lee County where citrus predominates.

The Big Cypress Basin, which encompasses a large, relatively pristine natural area, is threatened by a rapidly growing human population and advancing agricultural development, particularly from the north in Hendry County.

3.13 RECREATION RESOURCES

Recreation opportunities abound in the study area. Central and south Florida is rich in water resources, with easy access to fresh, estuarine and marine resources for fishing, boating, swimming, diving, camping, and sightseeing. Within the upper basin of the Kissimmee River region are dozens of freshwater lakes, popular for boating and fishing. Marinas, fishcamps, and public facilities (boat launching, picnicking, bank fishing) are located around many lakes in the region. Thirty-six miles of the Florida Scenic Trail were designated in June 1990 with additional trail section designations to follow. Lake Kissimmee State Park, Three Lakes, Kissimmee River and Kicco Wildlife Management Areas, and Prairie Lakes Preserve provide upland and water based recreation resources for the region.

Lake Okeechobee is the second largest freshwater lake within the continental United States and is a nationally recognized bass and pan fishing resource. Thousands of "snow birds" flock to the shores of Lake Okeechobee where they spend winter months fishing and enjoying the south Florida weather. The Lake offers other recreational amenities as well. Air boat and swamp buggy rides, bike riding, hiking, picnicking, camping, and nature interpretation are popular land based recreation activities in the region.

The urbanized east coast includes good quality marine based recreation activities such as underwater diving, salt water and estuary fishing, boating, surfing and, of course, the beach. County and state parks, scenic rivers, state reserves and forests, and Federal refuges provide wildlife viewing, nature interpretation, hiking, and canoeing opportunities. The Atlantic Intracoastal Waterway provides a diverse water-based recreation resource opportunity in the region. The Loxahatchee National Wild and Scenic River, Indian River Lagoon, DuPuis Reserve State Forest, J.W. Corbett Wildlife Management Area, and the Loxahatchee River – Lake Worth Creek Aquatic Preserve provide high quality recreation opportunities for boating, fishing, and nature interpretation activities within the coastal region.

Recreation resources in the Water Conservation Area region are inland water and upland resources that include the Arthur R. Marshall Loxahatchee National Wildlife Refuge Rotenberger and Holey Land Wildlife Management Areas, and (FDEP, 1994). These areas provide high quality boating, fishing, and nature interpretation activities. The Miccosukee State Indian Reservation is within the Water Conservation Area region boundary. Hunting, boating, and fishing occur

within the reservation. Fishing, hunting, boating and airboating are popular activities within the Water Conservation Areas. North of the Water Conservation Areas, in the Everglades Agriculture Area, there is the CREW Wildlife and Environmental Area and the Lake Harbor Public Waterfowl Area. The L-29 Borrow Canal which divides Water Conservation Area 3 from Everglades National Park is a popular fishing destination for residents of the Lower East Coast region. The L-67A and L-67C Canals are sport fishery resources of state-wide importance and support several bass fishing tournaments throughout the year.

Biscayne Bay offers among the highest quality recreation opportunities within the study area including fishing, shellfishing, sailing, motorboating, swimming, snorkeling, and canoeing. Biscayne National Park provides opportunities for birdwatching, recreational hiking, boating, fishing, snorkeling, diving and picnicking.

Everglades National Park and Florida Bay offer unique and diverse opportunities for a variety of natural resource and wilderness based recreational activities. Day use and camping (front and backcountry) facilities are available throughout the Park. There are over 150 miles of walking and canoe trails, including 2 miles of elevated boardwalk trails and three campgrounds with over 420 campsites and an additional 48 backcountry campsites in the Park. Recreation activities include: hiking, boating and canoeing, fishing, bird and wildlife viewing, and guided interpretive tours.

Everglades National Park has been designated a World Heritage Site, and International Biosphere Reserve, and a Wetland of International Significance. In addition, 86% of the Park is designated Wilderness under the Wilderness Act of 1964. The State of Florida has designated the Park an Outstanding Florida Water.

Diverse ecosystems from sawgrass prairie to pinelands and hammocks to the estuarine environment of Florida Bay area easily accessible from the main park road or the Shark Valley tram road. The main park road ends at Flamingo, a former fishing village, and a main port of entry to Florida Bay, where a variety of self-guided, concession or ranger led walks and boat tours are available. U.S. 29 leads to Everglades City and the Gulf Coast Visitor Center where the island-bay-mangrove ecosystems of the 99 mile Wilderness Waterway and Chokoloskee Bay, Turner River, and the Ten Thousand Islands area can be accessed. Chekika, a former state park, offers a slightly different experience with opportunities for a soak in a sulfur pool as well as for picnicking and hiking. Nearby is the Southern Glades Wildlife and Environmental Area which is managed by the Florida Game and Freshwater Fish Commission.

The Florida Keys, are world renowned as diving and sportfishing destinations. Boating, fishing, diving, and nature interpretation are some of the

many recreation opportunities in the region. Five wildlife refuges are located in the region and one of the busiest parks in the state. Several state parks are also within the region including John Pennekamp Coral Reef State Park, Key Largo National Marine Sanctuary, designates for the protection of the delicate reefs outside of Pennekamp, which is also a popular diving destination. Diving is the most popular recreation activity followed by fishing, and bird watching.

The Big Cypress region provides a unique wilderness area where recreation is primarily wetland based with some upland access and facility use. Air boating, fishing, hunting, and nature interpretation are all very popular recreation activities in the region. Camping facilities are also found within the region. Five state parks and recreation areas are located in the region as is a state preserve, the Panther National Wildlife Refuge, and National Audubon Society's Corkscrew Swamp Sanctuary.

The Caloosahatchee River provides approximately 67 miles of navigable waterway with ten Corps recreation facilities that include boating, fishing, picnicking, and camping. The J.N. "Ding" Darling National Wildlife Refuge, a popular birding area, administers Caloosahatchee National Wildlife Refuge, Matlacha Pass National Wildlife Refuge, Island Bay National Wilderness area and Pine Island National Wildlife Refuge, all located near the region's western edge. In Charlotte county there is the Fred C. Babcock/Cecil M. Webb Wildlife Management Area. Boca Grande Pass is world renowned for record tarpon, Sanibel Island is reported among the top shelling destinations in the Western Hemisphere,

3.14 AESTHETICS

The visual characteristics of the central and south Florida region can be roughly described for the dominant three land use categories (natural areas, such as those areas within the Everglades Protection Area, agricultural lands, and urban areas). Regional aesthetics depends in a large part on one's personal perspective. Where one lives, spends recreational time, makes a living, and who one perceives oneself to be, contributes to a personal perspective and opinion of what is aesthetically pleasing, and what is not.

Very briefly, the natural areas are composed of a variety of upland and wetland based ecosystems including lakes, sloughs, ponds, and vast expanses of marsh and wet prairie with varying vegetative components. Uplands are often dominated by pine, although other sub-tropical and tropical hardwoods such as fig, gumbo limbo, and cypress occur within their ecotone. Overall the land is remarkably flat, with few natural topographic rises such as hills or other geographic undulations. Much of the visible topographic features are man-made, including ubiquitous canals and levees. Additional man-made features of the landscape

include pump stations, navigation locks, secondary and primary roads, highways, electrical wires, communication towers, occasional buildings (some abandoned), borrow pits and other features which may or may not detract from the regional aesthetic. Views, when possible from a high perspective such as atop a levee, offer pleasant and unspoiled perspectives on Everglades marsh, often dotted with tree islands, and numerous birds and other wildlife.

One of the most prominent levees in the C&SF Project system is the Herbert Hoover Dike, over 140 miles of levee surrounding Lake Okeechobee. The impact of this levee on the lake's regional aesthetics has been permanent and profound. What is otherwise a scenic and immense natural water body with a profusion of wildlife along the shoreline, is nearly invisible to the casual observer because the Herbert Hoover Dike effectively blocks one's view. This is an example of the types of aesthetic impacts to key regional and local natural resources that the Restudy must strive to avoid.

Other key natural areas of particularly high aesthetic quality include among others, the Loxahatchee Slough, large areas of the Big Cypress National Preserve, the interior of some of the Water Conservation Areas, Loxahatchee National Wildlife Refuge, the Ten Thousand Islands, Everglades National Park, Florida Bay, and Biscayne Bay. The Florida Keys and the coral reef tract provide important aesthetic qualities to the state as well as some of the most significant underwater aesthetics in the world.

Agricultural lands occur throughout the system outside of the Everglades Protection Area. They are comprised largely of open pastureland north of Lake Okeechobee, in the Caloosahatchee region and northern Big Cypress region, where dairy and beef cattle operations predominate. The Kissimmee River region, for instance, is primarily pasture, with patchy natural areas, that function to retain water for the regional system. The Lower Basin of the Kissimmee River region is largely undeveloped and presents a panoramic landscape largely untouched by mankind for miles. The C-38 Canal is straight and wide and in the process of being "restored". Project earth moving equipment, as well Avon Park Bombing Range aircraft, break the panoramic scenery and detract from the otherwise high visual quality.

In the Everglades Agriculture Area, sugarcane production, and to a lesser extent sod, vegetables and rice lend a uniform and organized appearance to the landscape, largely devoid of trees and other non-agricultural vegetation. The view is rather monotonous and of marginal value. Agriculture in the Upper East Coast and in South Miami-Dade County is somewhat less intensive than the Everglades Agriculture Area and so a more traditional agricultural landscape, with more diverse crops such as citrus and a variety of tropical trees, shrubs and landscape plants predominates. Both the natural areas described above, and the agricultural

areas are relatively open, with low population density, few buildings and other structures interspersed across the landscape, and are generally quiet.

The urban areas, other than the scattered small to medium sized municipalities characteristic of the interior regions, occur mostly along the highly urbanized east coast. This includes such sprawling, mostly low level cityscapes as Stuart, Fort Pierce, West Palm Beach, Boca Raton, Pompano Beach, and nearby urban areas. Fort Lauderdale and Miami and their surrounding suburban areas epitomize the highly urbanized scene described above, only with significant high rise buildings in the downtown area nearest the coast or on nearby barrier islands. These cities are visually congested with immense residential areas, composed mostly of one or two story buildings, well-trafficked roads, seemingly endless impervious surfaces, parking lots, strip malls, high rise hotels, and industrial and commercial enterprise. The urbanized east coast begins more or less at the Florida Turnpike, and extends eastward to the coast. It includes intensively developed residential communities, highways and heavily used roads, and other development immediately adjacent or nearby to protected natural areas or agricultural lands. Visual aesthetics are marginal except in areas where urban landscaping assumes a high priority.

Along the coast, the Atlantic Ocean and Atlantic Intracoastal Waterway shorelines provide panoramic aesthetic views from many locations. White shoreline sand contrasts sharply with blue and green waters of the ocean and Atlantic Intracoastal Waterway in the region. High-rise structures, often hotels to serve the tourist industry, restrict visual access to the ocean's panoramic scenery and tend to diminish the visual experience from the shoreline. Visual access to the scenic Atlantic Intracoastal Waterway is also limited.

3.15 CULTURAL RESOURCES

The earliest widely accepted date of occupation of Florida is around 12,000 years ago. This earliest cultural period is termed the Paleo-Indian stage and lasted until about 7500 B.C.

The Archaic stage (ca. 7500 B.C. - ca. 500 B.C.) is thought to be a reflection of man's adaptation to the changing environment at the start of the Holocene, when our basically modern climate and biota were established. Foraging and hunting are the main subsistence activities throughout the Archaic stage, with Late Archaic people exploiting a larger territory and wider range of aquatic and terrestrial food resources.

In the Okeechobee Basin, the Belle Glades culture sequence (ca. 500 B.C. - A.D. 1500) is subdivided into four periods based on ceramic and other material

remains. A complex political system practiced by the Calusa was recorded in the late Belle Glades sequence. Objects of Spanish origin obtained from European contact or shipwreck salvage have been recovered from sites dating to the late periods of the Belle Glades.

The Caloosahatchee River is often identified as a separate cultural area. During the pre-Columbian period the river likely served as a vital transportation route to the Okeechobee Basin and the Glade culture areas. Large shell mound and shell midden sites characterize the Caloosahatchee coastal area. Sand burial mounds and shell and earth middens are typically found inland along the river. Smaller dirt middens are found on interior hammocks near freshwater marshes.

During the early historical period, beginning with the first Spanish colonial period (1513 - 1763), European contacts were limited to the coastal areas. It is estimated that approximately 10,000 Calusas inhabited southern Florida prior to contact with Europeans. The Calusas were hunters and gatherers concentrated primarily in coastal areas, subsisting by fishing, collecting shellfish, and gathering wild plants for food.

Interaction between Spanish and French explorers and the Calusas occurred during the 16th century. The European settlers attempted to convert the Native Americans to Christianity and alter their social structure. The Spanish retreated from Florida in the 1570's, leaving the Calusas undisturbed during the 1600's. Approximately 6,000 Calusas remained, but disease and occasional European invaders continued to reduce the population.

The Miccosukees are descendants of the Hitchiti-speaking Lower Creeks, and the Seminoles of the Muskogee-speaking Upper Creeks. These groups migrated to Florida in the 18th and 19th centuries from Georgia and Alabama. Then as now, the ethnic distinction between the Miccosukees and Seminoles stems mainly from a difference in language.

By the early 1800's, the migrant Native American population of Florida had grown to about 5,000. Miccosukee and Seminole Indians settled primarily in Northern Florida originally. Removal and relocation of many Indians to reservations west of the Mississippi River occurred as a result of the Seminole Wars of the 1800's and the Indian Removal Act of 1830. Following the United States government policy of Indian removal, the remaining Miccosukees and Seminoles moved farther south and established themselves in the Everglades, Big Cypress Swamp, and the Ten Thousand Islands. Most of the people lived on upland tree islands (hammocks), and used dugout canoes for transportation, hunting, and trading. Dwellings, called chickees, were constructed of cypress logs and palm fronds. The traditional lifestyle endured for the remainder of the century and still endures to a certain extent.

The first efforts to drain and reclaim the Everglades began in 1881. Agriculture began in the Everglades, south of Lake Okeechobee, after drainage projects of the 1906-1927 era. During this period, the first settlements, Okeelanta and Glade Crest were established just south of the lake. By 1921, there were 16 settlements on or near Lake Okeechobee, with a total estimated population of 2,000. Settlement and agricultural activities escalated during the subsequent decades.

By the early 20th century, hundreds of sport and commercial hunters were exploiting the Everglades resources. The opening of Tamiami Trail in 1928 ensured easy access for hunters and trappers to the southern Everglades. Permanent homes were rare, and the isolation and harsh environment compelled people to be self-reliant. Although soils in the area were fertile, it was the exploitation of fishery resources, along with animals and birds for skin and feathers, which was most economically important.

3.16 HAZARDOUS, TOXIC AND RADIOACTIVE WASTE

A preliminary Phase I Hazardous, Toxic and Radioactive Waste (HTRW) assessment was conducted in August 1998 to address the existence of potential for occurrence of HTRW on lands, including structures and submerged lands, in the study area. The assessment included a project review, review of site literature and Alternative D-13R project features, database search, review of available records and aerial photography, site inspections and interviews. The following potential indicators were looked for: landfills, dumps, disposal areas, aboveground and underground storage tanks, vats, containers of unidentified substances, spills, seepage, slicks, odors, dead or stressed vegetation, water treatment plants, wells, ditches, abandoned buildings, and transport areas (such as boat yards, harbors, rail yards, airports, truck terminals, and fueling stations).

The assessment covered all Restudy regions, within the general vicinity of proposed project features or existing features proposed for significant modification. Several site visits were conducted over the past few years, with the most recent field survey having been performed during the week of 10-14 August 1998. The project conditions assume that any HTRW found during any phase of the project would be remediated in accordance with local, state and Federal laws. The results of the Phase I assessment and data base search are included in ***Section 8*** and ***Appendix K.***